

Medications



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Bronchodilators – Sympathomimetic

Effects

Airway relaxation, increased ciliary beat frequency, increased force of contraction of skeletal muscles, arrest uterine smooth muscle contractions, and intracellular potassium shift.

Mechanism of Action

Drug binds to beta₂ receptors in airway smooth muscle, stimulating the production of cAMP, thus causing bronchodilation and increased ciliary beat frequency. Activation of Na⁺/K⁺/ATPase leads to gluconeogenesis and increased insulin secretion, resulting in an intracellular shift of potassium which can lead to metabolic lactic acidemia.

Products available

Generic Name	Trade Name	Dosage form	Duration of action	Receptor selectivity
Albuterol	Proventil® Proventil® HFA Ventolin® HFA Ventolin® Nebules AccuNeb® VoSpire ER™	Inhalation Oral	Intermediate acting	Beta1 < Beta2
Formoterol	Foradil aerolizer®	Inhalation	Long acting	Beta1 < Beta2
Levalbuterol	Xopenex® Xopenex® HFA	Inhalation	Intermediate acting	Beta1 < Beta2
Metaproterenol	Alupent®	Inhalation Oral	Intermediate acting	Beta1 < Beta2
Pirbuterol	Maxair autohaler™	Inhalation Oral	Intermediate acting	Beta1 < Beta2
Salmeterol	Serevent diskus®	Inhalation	Long acting	Beta1 < Beta2
Terbutaline	Brethine®	Inhalation Oral Intravenous	Intermediate acting	Beta1 < Beta2

Special Populations

Elderly: More sensitive to tachycardia and tremor.

Pregnancy: Beta-agonists decrease uterine contractility, use with caution during second and third trimesters of pregnancy.

Lactation: Some agents are excreted in human breast milk.

Children: Safety and efficacy data in young children is incomplete.

Precautions/Contraindications:

- Cardiac disease
- Thyroid disease
- Hypokalemia
- Hypersensitivity to the drug or its excipients
- Diabetes mellitus
- Seizure disorder
- Pheochromocytoma
- Glaucoma
- Shock

Adverse Drug Effects:

Adverse drug reactions are usually minor. Low absorption from the lung with inhaled agents limits systemic effects. Choice of a beta₂ selective agent decreases cardiac effects. However, when used at high doses, these agents are less selective for beta₂ receptors.

- Palpitations
- Tachycardia
- Hypertension
- Arrhythmias
- Cough
- Wheezing
- Bronchospasm
- Dyspnea
- Shakiness
- Throat dryness or irritation
- Pharyngitis
- Tremors
- Vasodilation
- Dizziness
- Headache
- Flushing
- Sweating
- Nervousness
- Excitement
- Insomnia
- Unusual or bad taste
- Anorexia
- Hypokalemia
- Lactic acidemia
- Gluconeogenesis
- Tension

Albuterol

Proventil®

Proventil® HFA

Ventolin® HFA

AccuNeb®

VoSpire ER™

ProAir® HFA

Class:

Bronchodilator - sympathomimetic

Use:

Bronchodilator for reversible airway obstruction in asthma or COPD. Prophylaxis for exercise-induced bronchoconstriction.

Dose:

Asthma: (Metered Dose Inhaler~MDI) 1-2 puffs every 4-6 hours as needed (≥4 years old)
(Neb) 2.5 mg 3-4 times daily

1.25 mg or 0.63 mg 3 times daily (2-12 years old)
(Oral) 2-4 mg 3-4 times daily

2 mg 3-4 times daily, MAX 24 mg/day (6-12 years old)
(Oral, ER) 4-8 mg every 12 hours, MAX 32 mg/day

Prevention of exercise induced bronchoconstriction:
(MDI) 2 puffs 15-30 minutes prior to exercise (≥4 years old)

Administration:

Metered dose inhaler (MDI): Shake well before using. Prime inhaler by releasing four sprays away from face. Prime prior to first use, whenever the MDI is not used for >72 hours, or if inhaler is dropped.

Oral: Do not chew or crush extended release tablets.

Nebulized solution: Dilute 0.5mL of the 0.5% solution with normal saline to a total of 3 mL to obtain the 2.5 mg/3mL solution. Albuterol solution is compatible with ipratropium or cromolyn nebulizer solutions. Do not exceed recommended dose.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Albuterol	MDI	90 mcg/ actuation	17 g (200 doses)	\$6.19
Proventil®	MDI	90 mcg/ actuation	17 g (200 doses)	\$38.10
Proventil® HFA	MDI (CFC free)	108 mcg/ actuation	6.7 g (200 doses)	\$39.61
Ventolin HFA®	MDI (CFC free)	108 mcg/ actuation	18 g (200 doses)	\$38.99
AccuNeb™	Nebulization	0.63 mg/3 mL	25 vials	\$43.26
		1.25 mg/3 mL	25 vials	\$43.26
Albuterol sulfate	Nebulization	0.083% (3 mL)	25 vials	\$18.99
		0.5%	20 mL	\$15.99
Albuterol sulfate	Oral syrup	2 mg/5 mL	120 mL	\$7.99
Albuterol sulfate	Tablet	2 mg	60 tablets	\$9.99
		4 mg	60 tablets	\$11.99
VoSpire ER™	Extended	4 mg	30 tablets	\$32.19
	release tablet	8 mg	60 tablets	\$125.99
Albuterol sulfate HFA	MDI (CFC free)	108 mcg/ actuation	8.5 g	\$30.11
Airet	Nebulization	0.083% (3 mL)	60 vials	\$99.99
			25 vials	\$49.69

Special Populations:

Elderly: More sensitive to adverse effects, especially tachycardia and tremor.

Pregnancy: Risk factor category C. Beta-agonists decrease uterine contractility, use with caution during second and third trimesters.

Lactation: Unknown if albuterol is excreted in human breast milk.

Children: No safety and efficacy data for immediate release tablets in children <6 years old (<12 years old for extended release tablets, <2 years for oral syrup and nebulized albuterol).

Precautions/Contraindications

- Diabetes mellitus
- Ischemic cardiac disease
- Coronary artery disease
- Hypertension
- Cardiac arrhythmias
- Tachycardia
- QT prolongation
- Thyroid disease
- Seizures
- Pheochromocytoma
- Hypokalemia
- Hypersensitivity to albuterol
- Hypersensitivity to levalbuterol

Adverse drug events:

Common: tachycardia, nervousness, palpitations, nausea, hypokalemia, and tremor

Serious: Stevens-Johnson syndrome (rare) and erythema multiforme in children (rare)

Drug interactions:

Interacting Agent	Effect	Management
Beta blockers	Antagonism of the effects of albuterol	Avoid concurrent use
CYP3A4 inducers (i. e.carbamazepine, phenytoin)	Decreased serum concentration of albuterol	Consider an alternative therapy Monitor therapeutic effects of albuterol
Theophylline derivatives	Increased theophylline toxicity Increased cardiotoxicity Decreased serum concentration of theophylline possible	Monitor serum concentration of theophylline Monitor serum potassium Monitor therapeutic and toxic effects of theophylline Adjust theophylline dose as needed
Halothane	Increased risk of arrhythmias	Avoid concurrent use
Ipratropium	Increased duration of bronchodilation	No action needed
Monoamine oxidase inhibitors (MAOI)	Increased incidence of side effects	Monitor heart rate and blood pressure
Tricyclic antidepressants	Increased incidence of side effects	Monitor heart rate and blood pressure
Sympathomimetics	Increased incidence of side effects	Monitor heart rate and blood pressure
Caffeine	Increased CNS stimulation	Avoid or limit caffeine consumption
Ephedra	Increased CNS stimulation	Avoid combination
Yohimbine	Increased CNS stimulation	Avoid combination
Atomoxetine	Increased incidence of tachycardia	Monitor heart rate and blood pressure
St. John's Wort	Decreased serum concentration of albuterol Avoid combination	Select a therapeutic alternative
Loop diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia
Thiazide diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia
Digoxin	Decreased serum concentration of digoxin	Monitor serum concentration of digoxin Monitor therapeutic effect of digoxin Adjust digoxin dose as needed

Formoterol

Foradil® Aerolizer™

Class:

Bronchodilator - sympathomimetic

Use:

Maintenance treatment of asthma for patients who require regular treatment with short-acting beta2-agonists bronchoconstriction in patients with COPD, and prevention of exercise-induced bronchoconstriction.

Dose:

Asthma: “(Dry Powdered Inhaler~DPI)” 12 mcg capsule every 12 hours via Aerolizer™ inhaler (≥5 years old)

COPD: “(Dry Powdered Inhaler~DPI)” 12 mcg capsule every 12 hours via Aerolizer™ inhaler

Prevention of exercise induced bronchospasm:

12 mcg capsule 15 minutes prior to exercise if needed via Aerolizer™ inhaler

MAX: 24 mcg/ 24hrs (≥5 years old)

Administration:

Capsule containing dry powder for inhalation: Remove capsule from protective foil immediately prior to use. Capsule must be placed in the capsule-chamber in the Aerolizer™ Inhaler. After the inhaler is closed, press both side buttons once and release. (This punctures the capsule releasing the dry powder for inhalation.) Exhale deeply, hold the inhaler horizontally, and inhale deeply and rapidly. Hold breath and exhale. If powder remains in the Aerolizer™ Inhaler, repeat. Discard the empty capsule. Do not wash the Aerolizer™ Inhaler or use with a spacer. Do not exceed recommended dose.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Foradil® Aerolizer™	Capsule containing powder for inhalation	12 mcg/capsule	60 capsules	\$97.45

Special Populations:

Elderly: More sensitive to adverse effects, especially tachycardia and tremor.

Pregnancy: Risk factor category C. Beta-agonists decrease uterine contractility: use with caution during second and third trimesters.

Lactation: Unknown if formoterol is excreted in human breast milk.

Children: No safety and efficacy data for children <5 years old.

Precautions/Contraindications

- Diabetes mellitus
- Ischemic cardiac disease
- Coronary artery disease
- Hypertension
- Cardiac arrhythmias
- Tachycardia
- QT prolongation
- Thyroid disease
- Seizures
- Pheochromocytoma
- Acute bronchospasm
- Status asthmaticus
- Hypokalemia
- Hypersensitivity to lactose
- Hypersensitivity to formoterol

Adverse drug events:

Common: headache, dizziness, palpitations, tremor, restlessness

Drug interactions:

Do not give with other long-acting beta-agonists (salmeterol).

Interacting Agent	Effect	Management
Beta blockers	Antagonism of the effects of albuterol	Avoid concurrent use
Atomoxetine	Increased incidence of tachycardia	Monitor heart rate and blood pressure
Sympathomimetics	Increase incidence of side effects	Monitor heart rate and blood pressure
Digoxin	Decreased serum concentration of digoxin	Monitor serum concentration of digoxin Monitor therapeutic effect of digoxin Adjust digoxin dose as needed
Loop diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia
Thiazide diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia
Theophylline derivatives	Increased theophylline toxicity Increased cardiotoxicity Decreased serum concentration of theophylline possible	Monitor serum concentration of theophylline Monitor serum potassium Monitor therapeutic and toxic effects of theophylline Adjust theophylline dose as needed
Monoamine oxidase inhibitors	Increase incidence of side effects	Monitor heart rate and blood pressure

Levalbuterol

Xopenex®

Xopenex® HFA

Class:

Bronchodilator - sympathomimetic

Use:

Treatment and prevention of bronchospasm in asthma

Dose:

Asthma: (Nebs) 0.63-1.25 mg nebulized every 6-8 hours (≥ 12 years old)
0.31 mg 3 times daily, MAX 0.63 mg 3 times daily (6-11 years old)

Administration:

Metered Dose Inhaler~MDI: 1-2 puffs every 4-6 hours (>4 years old).

Nebulized solution: Dilute 0.5mL of the solution with normal saline to a total of 3 mL prior to use. Vials should be kept at room temperature and protected from light. Use vials within 2 weeks after foil package is opened. Use within 1 week if vials are stored outside the protective package.

Do not exceed recommended dose.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Xopenex®	Nebulization	0.31 mg/3mL	24 vials	\$65.43
Xopenex® HFA	MDI	0.63 mg/3mL	24 vials	\$65.74
		1.25 mg/3mL	24 vials	\$65.74
		45mcg/actuation	15gm(200 doses)	\$48.99

Special Populations:

Renal Impairment: Higher serum concentrations obtained.

Elderly: More sensitive to adverse effects, especially tachycardia and tremor.

Pregnancy: Risk factor category C. Beta-agonists decrease uterine contractility, use with caution during second and third trimesters.

Lactation: Unknown if levalbuterol is excreted in human breast milk.

Children: No safety and efficacy data for nebulized levalbuterol use in children <6 years old, or for aerosolized levalbuterol use in children <4 years old.

Precautions/Contraindications:

- Diabetes mellitus
- Ischemic cardiac disease
- Coronary artery disease
- Hypertension
- Cardiac arrhythmias
- Tachycardia
- QT prolongation
- Thyroid disease
- Seizures
- Pheochromocytoma
- Hypokalemia
- Hypersensitivity to levalbuterol
- Hypersensitivity to albuterol

Adverse drug events:

Common: sinusitis, rhinitis, viral infection, flu syndrome serious (rare): hypersensitivity reactions, ECG changes, cardiovascular effects, paradoxical bronchospasm

Drug interactions:

Interacting Agent	Effect	Management
Beta blockers	Antagonism of the effects of levalbuterol	Avoid concurrent use
Atomoxetine	Increased incidence of tachycardia	Monitor heart rate and blood pressure
Sympathomimetics	Increase incidence of side effects	Monitor heart rate and blood pressure
Digoxin	Decreased serum concentration of digoxin	Monitor serum concentration of digoxin Monitor therapeutic effect of digoxin Adjust digoxin dose as needed
Loop diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia
Thiazide diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia

Metaproterenol

Alupent®

Class:

Bronchodilator - sympathomimetic

Use: Bronchodilation in asthma or COPD with reversible airway obstruction.

Dose:

Asthma: (Metered Dose Inhaler~MDI) 1-3 puffs every 3-4 hours, MAX 12 puffs/day (≥12 years old)

(Neb) 15 mg every 4-6 hours, or more often if needed (≥12 years old)
5-10 mg every 4-6 hours, or more often if needed (6-12 years old)

(Oral) 20 mg 3-4 times daily (≥9 years old)
10 mg 3-4 times/day (6-9 years old)
1.3-2.6 mg/kg/day divided into 3-4 doses (2-6 years old)
0.4 mg/kg every 8-12 hours (<2 years old)

Administration: Do not exceed recommended dose.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Alupent®	MDI	0.65 mg/acutation	14 g (200 doses)	\$32.87
Alupent®	Nebulization	0.4% (2.5 mL)	25 vials	\$55.99
		0.6% (2.5 mL)	25 vials	\$55.99
		5%	10 mL	\$21.99
		5%	30mL	\$55.99
Metaproterenol sulfate	Nebulization	0.4% (2.5mL)	30 vials	\$39.99
		0.6% (2.5mL)	25 vials	\$33.99
		5%	10 mL	\$18.99
Metaproterenol sulfate	Oral syrup	10 mg/mL	240 mL	\$12.00
Metaproterenol sulfate	Oral tablet	10mg	60 tablets	\$20.99
		20mg	60 tablets	\$23.99

Special Populations:

Elderly: More sensitive to adverse effects, especially tachycardia and tremor.

Pregnancy: Risk factor category C. Beta-agonists decrease uterine contractility, use with caution during second and third trimesters.

Lactation: Unknown if metaproterenol is excreted in human breast milk.

Children: No safety and efficacy data for tablet use in children <6 years old or for aerosol use in children <12 years old.

Precautions/Contraindications:

- Hypersensitivity to metaproterenol
- Diabetes mellitus
- Ischemic cardiac disease
- Coronary artery disease
- Hypertension
- Cardiac arrhythmias
- Tachycardia
- QT prolongation
- Thyroid disease
- Seizures
- Pheochromocytoma

Adverse drug events:

Common: tachycardia, hypertension, palpitations, nervousness, nausea, tremor, flushing

Serious: cardiac arrest, paradoxical bronchospasm (rare)

Drug interactions:

Interacting Agent	Effect	Management
Beta blockers	Antagonism of the effects of metaproterenol	Avoid concurrent use
Atomoxetine	Increased incidence of tachycardia	Monitor heart rate and blood pressure
Sympathomimetics	Increase incidence of side effects	Monitor heart rate and blood pressure
Digoxin	Decreased serum concentration of digoxin	Monitor serum concentration of digoxin Monitor therapeutic effect of digoxin Adjust digoxin dose as needed
Loop diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia
Thiazide diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia

Pirbuterol

Maxair Autohaler™

Class:

Bronchodilator - sympathomimetic

Use:

Treatment and prevention of reversible bronchospasm.

Dose:

Asthma: (Metered Dose Inhaler~MDI) 1-2 puffs every 4-6 hours as needed, up to 12 puffs/day (≥12 years old)

Administration:

Autohaler™: Holding the Autohaler™ upright, move the lever to it snaps into position, perpendicular to the floor. Shake the device well. Exhale completely. Begin inhalation and move the Autohaler™ lever down to original position, continue inhaling deeply. Hold breath for at least 10 seconds, then exhale slowly. The Autohaler™ should be primed by spraying an actuation by pressing the white test-fire slide located at the bottom of the device. Prime when the inhaler is new or has been unused for more than 48 hours.

Do not exceed recommended dose.

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Maxair Autohaler™	Aerosol delivered by the Autohaler™	200 mcg/actuation	14 g (400 doses)	\$94.76

Special Populations:

Elderly: More sensitive to adverse effects, especially tachycardia and tremor.

Pregnancy: Risk factor category C. Beta-agonists decrease uterine contractility, use with caution during second and third trimesters.

Lactation: Unknown if pirbuterol is excreted into human breast milk.

Children: No safety and efficacy data for children <12 years old.

Precautions/Contraindications

- Diabetes mellitus
- Ischemic cardiac disease
- Coronary artery disease
- Hypertension
- Cardiac arrhythmias
- Tachycardia
- QT prolongation
- Thyroid disease
- Seizures
- Pheochromocytoma
- Hypersensitivity to pirbuterol
- Shock
- Narrow-angle glaucoma
- AV block associated with digitalis toxicity
- Hypokalemia

Adverse drug events:

Common: tremor, nervousness

Serious: paradoxical bronchospasm

Drug interactions:

Interacting Agent	Effect	Management
Beta blockers	Antagonism of the effects of pirbuterol	Avoid concurrent use
Atomoxetine	Increased incidence of tachycardia	Monitor heart rate and blood pressure
Sympathomimetics	Increase incidence of side effects	Monitor heart rate and blood pressure
Digoxin	Decreased serum concentration of digoxin	Monitor serum concentration of digoxin Monitor therapeutic effect of digoxin Adjust digoxin dose as needed
Loop diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia
Thiazide diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia

Salmeterol

Serevent Diskus®

Class:

Bronchodilator - sympathomimetic

Use:

Maintenance treatment of asthma for patients who require regular treatment with short-acting beta2-agonists bronchoconstriction in patients with COPD, and prevention of exercise induced bronchoconstriction.

Dose:

Asthma: Dry Powdered Inhaler~DPI 1 inhalation every 12 hours (≥4 years old)

COPD: Dry Powdered Inhaler~DPI 1 inhalation every 12 hours

Prevention of exercise induced bronchospasm:

1 inhalation 30 minutes prior to exercise (≥4 years old)

Administration:

Do not exceed recommended dose.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Serevent Diskus™	DPI	50 mcg/dose	1 inhaler with 60 doses	\$98.90

Special Populations:

Elderly: More sensitive to adverse effects, especially tachycardia and tremor.

Pregnancy: Risk factor category C. Beta-agonists decrease uterine contractility, use with caution during second and third trimesters.

Lactation: Unknown if salmeterol is excreted into human breast milk.

Children: No safety and efficacy data for children <4 years old.

Precautions/Contraindications:

- Acute bronchospasm
- Status asthmaticus
- Hypersensitivity to salmeterol
- Diabetes mellitus
- Ischemic cardiac disease
- Coronary artery disease
- Hypertension
- Cardiac arrhythmias
- Tachycardia
- QT prolongation
- Thyroid disease
- Seizures
- Pheochromocytoma

Terbutaline

Brethine®

Class:

Bronchodilator - sympathomimetic

Use:

Bronchodilator in asthma and COPD with reversible airway obstruction.

Dose:

Bronchospasm:

(Oral) 2.5-5 mg three times daily, MAX 15mg/day (adult)

2.5-5 mg three times daily, MAX 7.5mg/day (12-15 years old)

0.05-0.15 mg/kg/dose three times daily, MAX 5mg/day (6-12 years old)

Administration:

Do not exceed recommended dose.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Brethine®	Tablet	2.5 mg	90 tablets	\$43.47
		5 mg	90 tablets	\$61.94

Special Populations:

Pregnancy: Risk factor category B. Fetal tachycardia has occurred secondary to parenteral administration. Beta-agonists decrease uterine contractility, use with caution during second and third trimesters.

Lactation: Terbutaline is excreted into human breast milk.

Precautions/Contraindications:

- Tachycardia
- Continuous use >12 months
- Diabetes mellitus
- Ischemic cardiac disease
- Coronary artery disease
- Hypertension
- Cardiac arrhythmias
- QT prolongation
- Thyroid disease
- Seizures
- Pheochromocytoma

Adverse drug events:

Common: tachycardia, nervousness, tremor, headache, seizures, palpitations

Serious: paradoxical bronchospasm, cardiac arrhythmias

Drug interactions:

Interacting Agent	Effect	Management
Beta blockers	Antagonism of the effects of terbutaline	Avoid concurrent use
Atomoxetine	Increased incidence of tachycardia	Monitor heart rate and blood pressure
Sympathomimetics	Increase incidence of side effects	Monitor heart rate and blood pressure
Digoxin	Decreased serum concentration of digoxin	Monitor serum concentration of digoxin Monitor therapeutic effect of digoxin Adjust digoxin dose as needed
Loop diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia
Thiazide diuretics	Enhanced hypokalemic effect	Monitor serum potassium Monitor symptoms of hypokalemia

Bronchodilators – Anticholinergic

Effects:

Bronchodilation through inhibition of bronchoconstriction secondary to blockade of the effects of acetylcholine.

Mechanism of Action:

The non-selective antagonism of muscarinic receptors leads to down regulation of cGMP which results in bronchodilation. Additional acetylcholine is released in response, thus overcoming the effect in smooth muscle.

Adverse Drug Reactions:

Administering the agent by inhalation increases selectivity for respiratory muscarinic receptors. Side effects of systemic absorption include blurred vision, CNS stimulation, dryness of secretions, and constipation.

Products Available:

Generic	Trade Name	Dosage Form
Ipratropium	Atrovent®	Metered dose inhaler (MDI) Dry powder for inhalation (DPI) Nasal
Tiotropium*	Spiriva® Handihaler	DPI

Special Populations:

Elderly: Greater risk for anticholinergic side effects.

Pregnancy: Insufficient data to recommend using during pregnancy.

Lactation: Anticholinergic effects may dry breast milk.

Children: Safety and efficacy data incomplete in young children.

Precautions/Contraindications:

- Cardiac arrhythmias
- Glaucoma
- Contact lenses
- Urinary retention
- Benign prostatic hypertrophy
- Driving or performing hazardous tasks
- Hypersensitivity to the drug or its excipients

Ipratropium

Atrovent®

Atrovent® HFA

Class:

Bronchodilator - anticholinergic

Use:

Treatment of bronchospasm in bronchitis, COPD, and emphysema. Treatment of rhinorrhea.

Dose:

Bronchospasm:

(Metered Dose Inhaler~MDI) 2 puffs four times daily, up to 12 puffs/day

1-2 puffs three times daily, up to 6 puffs/day (3-14 years old)

(Neb) 500 mcg three to four times daily

125-250 mcg three times daily (infants)

25 mcg/kg three times daily (neonates)

Rhinorrhea, non-allergenic or perennial allergic:

(Nasal) 2 sprays (0.03%) in each nostril 2-3 times daily (≥6 years old)

Rhinorrhea, common cold:

(Nasal) 2 sprays (0.06%) in each nostril 3-4 times daily, up to 4 days (≥5 years old)

Rhinorrhea, seasonal allergy:

(Nasal) 2 sprays (0.06%) in each nostril 4 times daily, up to 3 weeks (≥5 years old)

Administration:

Prime inhaler with two test sprays when inhaler is new or has not been used >72 hours.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Atrovent®	Nebulization	0.02% (2.5 mL)	25 vials	\$77.32
Atrovent®	MDI	18 mcg/actuation	14.7 g	\$71.99
Atrovent® HFA	MDI (CFC free)	17 mcg/actuation	12.9 g	\$72.99

Atrovent®	Nasal spray	0.03%	30 mL	\$55.95
		0.06%	15 mL	\$48.27

Special Populations:**Pregnancy:** Risk factor category B.**Lactation:** Ipratropium is excreted into human breast milk.**Children:** No safety and efficacy data for children <5 years old.**Precautions/Contraindications:**

- Hypersensitivity to soya lecithin
- Hypersensitivity to peanut oil
- Hypersensitivity to atropine
- Hypersensitivity to bromide
- Closed-angle glaucoma
- Contact lenses
- Urinary tract obstruction
- Benign prostatic hypertrophy
- Urinary retention

Adverse drug events:**Common:** nasal congestion, nasal dryness, bitter taste, dry mouth**Serious:** paralytic ileus (rare), hypersensitivity reactions (rare)**Drug Interactions**

Interacting Agent	Effect	Management
Pramlintide	Increased anticholinergic effect Decreased GI motility	Avoid combination if possible Monitor side effects
Anticholinergics	Increased anticholinergic effects	Monitor anticholinergic side effects Use with caution

Tiotropium

Spiriva Handihaler®

Class:

Bronchodilator - anticholinergic

Use:

Prevention and treatment of bronchospasm in COPD. Not currently approved for treatment of asthma.

Dose:

Bronchospasm: Dry Powdered Inhaler~DPI 1 capsule (18 mcg) daily via the HandiHaler® inhaler (≥18 years old)

Administration:

Not compatible with other delivery systems.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Spiriva® HandiHaler®	DPI	18 mcg/capsule	30 capsules	\$163.47

Special Populations:

Elderly: Greater risk for anticholinergic side effects and complications.

Pregnancy: Risk factor category C.

Lactation: Unknown if tiotropium is excreted in human breast milk.

Children: No safety and efficacy data in children <18 years old.

Precautions/Contraindications

- Hypersensitivity to tiotropium
- Hypersensitivity to ipratropium
- Hypersensitivity to lactose
- Closed-angle glaucoma
- Cardiac arrhythmias
- Driving or operating machinery
- Ophthalmic administration
- Contact lenses
- Urinary tract obstruction
- Benign prostatic hypertrophy
- Urinary retention

Adverse drug events:

Common: dry mouth, blurred vision, glaucoma, sinusitis, increased heart rate, respiratory tract infection, urinary difficulty/retention, constipation

Drug interactions:

Interacting Agent	Effect	Management
Pramlintide	Increased anticholinergic effects Decreased GI motility	Avoid combination if possible Monitor side effects
Anticholinergics	Increased anticholinergic effects	Monitor anticholinergic side effects Use with caution
Cimetidine	Decreased metabolism of tiotropium	No action required.

Inhaled Corticosteroids

Effects:

Reduced airway inflammation. Overall airway bronchial hyper-responsiveness decreased. Improved asthma control. Increased sensitivity of beta-receptors in smooth muscle.

Mechanism of Action:

Agents suppress granuloma formation, reduce arachadonic acid metabolism, up regulate beta-adrenergic receptors on leukocytes, and decrease synthesis of prostaglandins and leukotrienes

Products available:

Beclomethasone	Metered dose inhaler (MDI) Nasal
Budesonide	Dry Powdered Inhaler (DPI) Nebulization Nasal Oral
Flunisolide	MDI Nasal
Fluticasone	MDI Nasal
Mometasone	DPI Nasal
Triamcinolone	MDI Nasal

Special populations:

Renal Impairment: Dose reduction may be necessary.

Hepatic Impairment: Dose reduction may be necessary.

Pregnancy: Insufficient data to recommend using during pregnancy.

Lactation: Some agents are excreted in breast milk.

Children: Safety and efficacy data incomplete in young children.

Precautions/Contraindications:

- Coagulopathy
- Acute bronchospasm
- Status asthmaticus
- Hypersensitivity to the drug or its excipients
- Cushing’s disease
- Diabetes mellitus
- Glaucoma
- Hypertension
- Osteoporosis
- Seizure disorder
- Tuberculosis
- Active infection
- Nasal trauma
- Myasthenia gravis
- Peptic ulcer disease
- Abrupt withdrawal
- Hypothyroidism

Adverse Drug Reactions:

Side effects are due to systemic absorption. Corticosteroids delivered by inhalation or nasally have less systemic absorption, thus cause fewer adverse drug reactions.

Candidiasis
 Nasopharyngeal
 irritation Glaucoma
 Cataracts
 Adrenal suppression
 Osteoporosis
 Headache
 Nasal stinging

Nasal dryness
 Throat irritation
 Cushing’s syndrome
 Dysphonia
 Palpitations
 Epistaxis
 Hypersensitivity
 reaction

Anaphylaxis
 Infection
 Hypertension
 GI distress
 Growth suppression
 Impaired healing
 Hyperglycemia

Beclomethasone

QVAR®

Beconase® AQ

Class:

Corticosteroid

Use:

Treatment and prophylaxis of asthma, nasal preparation for allergic rhinitis.

Dose:

Asthma:

Metered Dose Inhaler~MDI 40 mcg twice daily, MAX 80 mcg twice daily (5-11 years old)
40-160 mcg twice daily, MAX 320 mcg twice daily (≥6 years old)

Allergic rhinitis:

(Nasal) 1-2 sprays each nostril twice daily, TOTAL 168-336 mcg/day

Administration:

Not for treatment of acute bronchospasm. Rinse mouth after use of oral inhaler.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
QVAR®	MDI	40 mcg/actuation	7.3 g (100 doses)	\$60.84
		80 mcg/actuation	7.3 g (100 doses)	\$73.57
Beconase® AQ	Aqueous nasal spray	42 mcg/ spray	25 g (180 doses)	\$81.36

Special Populations:

Pregnancy: Risk factor category C.

Lactation: Excreted in breast milk.

Children: No safety and efficacy data for children < 6 years old or for QVAR® use in children <5 years old.

Precautions/Contraindications:

- Status asthmaticus
- Hypersensitivity to beclomethasone
- Cushing's disease
- Diabetes mellitus
- Glaucoma
- Tuberculosis
- Active infection
- Abrasions/trauma at site of application

Adverse drug events:

Common: headache, candidiasis, nasopharyngeal irritation

Serious: glaucoma, cataract, adrenal suppression, osteoporosis

Drug interactions:

No clinically significant interactions currently identified.

Budesonide

Pulmicort Turbuhaler®

Pulmicort Respules®

Rhinocort® Aqua®

Class:

Corticosteroid

Use:

Maintenance treatment of asthma. Intranasal for rhinitis symptoms.

Dose:

Asthma:

(Dry Powder Inhaler~DPI) 1-4 puffs twice daily, MAX 4 puffs twice daily

1 puff twice daily, MAX 2 puffs twice daily (≥6 years old)

(Nebs) 0.5 mg once daily or divided twice daily, MAX 1 mg/day (1-8 years old)

Rhinitis:

(Nasal) 0.25mg -1 spray each nostril daily, MAX 4 sprays/nostril daily (≥12 years old)

1 spray each nostril daily, MAX 2 sprays/nostril daily (6-12 years old)

Administration:

Not for treatment of acute bronchospasm. Rinse mouth after use of Turbuhaler®.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Pulmicort Turbuhaler®	DPI	200 mcg/actuation	104 g (200 doses)	\$148.12
Rhinocort® Aqua	Nasal spray	32 mcg/actuation	8.6 g	\$69.99
Pulmicort Respules®	Nebulization	0.25 mg/2mL	30 vials	\$145.04
		0.5 mg/2mL	30 vials	\$156.50

Special Populations:

Renal Impairment: Drug may exacerbate impairment.

Elderly: Increased risk for liver dysfunction.

Pregnancy: Pulmicort® Turbuhaler®, Pulmicort® Respules®, and Rhinocort® Aqua fall into pregnancy risk factor category B. All other forms of budesonide are considered to be in pregnancy risk factor category C.

Lactation: Budesonide is excreted in human breast milk.

Children: Nebulized budesonide is indicated in children ≥ 6 months old.

Precautions/Contraindications:

- Status asthmaticus
- Hypersensitivity to budesonide
- Tuberculosis
- Active infection
- Cushing's disease
- Myasthenia gravis
- Abrasion/trauma at site of drug application
- Hypertension
- Osteoporosis
- Psychosis
- Diabetes mellitus
- Seizure disorder
- Peptic ulcer disease
- Glaucoma
- High risk for intestinal perforation

Adverse drug events:

Common: headache, nasal stinging, nasal dryness, throat irritation, epistaxis, Cushing's syndrome

Serious: cataract, glaucoma, adrenal suppression

Drug interactions

Interacting Agent	Effect	Management
CYP3A4 inhibitors (i.e. cimetidine)	Decreased metabolism of budesonide	Monitor therapeutic effects of budesonide
Antacids	Decreased bioavailability of oral budesonide	Separate doses by two or more hours. Monitor therapeutic effects of budesonide
Bile acid binders	Decreased oral absorption of budesonide	Separate doses by two or more hours. Monitor therapeutic effects of budesonide
Imidazole antifungals	Decreased metabolism of budesonide	Monitor toxic effects of budesonide, i.e. adrenal suppression
Protease inhibitors	Decreased metabolism of budesonide	Monitor toxic effects of budesonide

Flunisolide

AeroBid®

Nasarel®

AeroBid® M

Class:

Corticosteroid

Use:

Management of steroid-dependent asthma, nasal preparation for allergic rhinitis.

Dose:

Asthma:

(Metered Dose Inhaler~MDI) 2 puffs twice daily, MAX 4 puffs twice daily
(2 mg/day)

2 puffs twice daily, MAX 2 puffs twice daily (1 mg/day) (6-14 years old)

Allergic rhinitis:

(Nasal) 2 sprays/nostril twice daily, MAX 8 sprays each nostril daily

1-4 sprays/nostril 1-3 times daily, MAX 4 sprays/nostril/day (6-14 years old)

Administration:

Rinse mouth after use of oral inhalation. Not for treatment of acute bronchospasm.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
AeroBid® AeroBid® M	MDI	250 mcg/actuation	7 g (100 doses)	\$74.57
Flunisolide	Nasal solution	0.025%	25 mL	\$37.99
Nasarel®	Nasal spray	29 mcg/actuation	25 mL	\$48.99

Special Populations:

Pregnancy: Risk factor category C.

Lactation: Unknown if excreted in breast milk.

Children: No safety and efficacy data for children < 6 years old.

Precautions/Contraindications:

- Status asthmaticus
- Cushing's disease
- Tuberculosis
- Active infection
- Hypersensitivity to flunisolide
- Oral or nasal trauma or ulcers
- Systemic fungal infection
- Osteoporosis

Adverse drug events:

Common: Headache, nausea, vomiting, nasal irritation, mouth and throat candidiasis, dysphonia, palpitations

Serious: Adrenal insufficiency

Drug interactions:

No clinically significant interactions currently identified.

Fluticasone

Flonase®

Flovent® HFA

Class:

Corticosteroid

Use:

Maintenance and prophylaxis of asthma, nasal preparation for rhinitis.

Dose:

Asthma:

(Metered Dose Inhaler~MDI) 100 mcg -1000 mcg twice daily,
MAX 2000 mg/day (≥12 years old)

50 mcg twice daily, MAX 100 mcg twice daily (4-11 years old)

Rhinitis:

(Nasal) 1-2 sprays each nostril 1-2 times daily, MAX 2 sprays/nostril/day
spray each nostril daily, MAX 2 sprays each nostril daily

Administration:

Rinse mouth after each use of oral inhalation. Not for treatment of acute bronchospasm.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Flonase®	Nasal spray	50 mcg/actuation	16 g	\$69.99
Flovent® HFA	MDI (CFC free)	44 mcg/actuation	10.6 g	\$69.09
		110 mcg/actuation	12 g	\$92.46
		220 mcg/actuation	12 g	\$131.00

Special Populations:

Pregnancy: Risk factor category C.

Lactation: Unknown if excreted in breast milk.

Children: No safety and efficacy data in children < 4 years old.

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Precautions/Contraindications:

- Hypersensitivity to fluticasone
- Milk protein hypersensitivity
- Status asthmaticus
- Acute bronchospasm
- Tuberculosis
- Active infection
- Systemic fungal infection
- Cushing's disease
- Abrasions/trauma at site of application
- Diabetes mellitus
- Osteoporosis

Adverse drug events:

Common: pharyngitis, epistaxis, oropharyngeal candidiasis

Serious: adrenal suppression, glaucoma (rare), anaphylaxis (rare), hypersensitivity reaction (rare)

Drug interactions:

Interacting Agent	Effect	Management
CYP3A4 inhibitors (i.e., cimetidine)	Decreased effect of fluticasone	Monitor therapeutic effects of fluticasone
Imidazole antifungals	Decreased metabolism of fluticasone	Monitor toxic effects of fluticasone
Protease inhibitors	Decreased metabolism of fluticasone	Monitor toxic effects of fluticasone

Mometasone

Nasonex®

Asmanex Twisthaler®

Class:

Corticosteroid

Use:

Treatment of allergic rhinitis and management of asthma.

Dose:

Asthma:

(Dry Powdered Inhaler~DPI) 1 puff (220 mcg) daily (≥12 years old),
MAX 440 mcg/day

Allergic Rhinitis:

(Nasal) 2 sprays each nostril daily (≥12 years old)
1 spray each nostril daily (2-11 years old)

Administration:

(Nasal): Prime nasal spray by pumping ten times or until a fine mist appears. Prime the device when new or unused for more than a week.

(DPI): Inhale quickly and deeply. Rinse mouth after use.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Nasonex	Nasal spray	50 mcg/actuation	17 g	\$67.99
Asmanex® Twisthaler®	DPI	0.22 mg/actuation	30 dosees	\$97.99
			60 doses	\$99.99
			120doses	\$143.63

Special Populations:

Pregnancy: Risk factor category C.

Lactation: Unknown if nasal mometasone is excreted in human breast milk.

Children: No safety or efficacy data for children < 2 years old.

Precautions/Contraindications:

- Status asthmaticus
- Hypersensitivity
- Diabetes mellitus
- Cushing's syndrome
- Abrupt discontinuation
- Nasal trauma
- Glaucoma
- Tuberculosis
- Active infection

Adverse drug events:

Common: epistaxis, headache, viral infection

Serious: glaucoma, adrenal suppression

Drug interactions:

No clinically significant interactions currently identified.

Triamcinolone

Azmacort®

Nasacort® AQ

Class:

Corticosteroid

Use:

Maintenance treatment of asthma and other bronchospastic conditions. Intranasal for rhinitis symptoms.

Dose:

Asthma:

(Metered Dose Inhaler~MDI) 2-4 puffs 2-4 times daily,

MAX 16 puffs/day (≥12 years old)

1-4 puffs 2-4 times daily, MAX 12 puffs/day (6-12 years old)

Rhinitis:

(IM) 40-100 mg intramuscularly once

(Nasal) 1-2 sprays each nostril daily (≥6 years old)

Administration:

Rinse mouth after use of oral inhalation.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Azmacort®	MDI	100 mcg/actuation	20 g	\$89.99
Nasacort® AQ	Nasal spray	55 mcg/actuation	16.5 g	\$67.99

Special Populations:

Renal Impairment: Use with caution.

Hepatic Impairment: Possible exaggerated response.

Pregnancy: Risk factor category C.

Lactation: Unknown if inhaled triamcinolone is excreted into breast milk.

Children: No safety and efficacy data of inhaled triamcinolone for children < 6 years old. Some parenteral preparations contain benzyl alcohol.

Precautions/Contraindications

- Acute status asthmaticus
- Acute bronchospasm
- Cushing's disease
- Nasal trauma
- Myocardial infarction
- Congestive heart failure
- Hypertension
- Psychosis
- Emotional instability
- Seizure disorder
- Hypothyroidism
- Tartrazine dye hypersensitivity
- Aspirin allergy
- Premature neonates
- Hypersensitivity to triamcinolone
- Concomitant immunosuppressive therapy
- Tuberculosis
- Active infection
- Osteoporosis
- Diabetes mellitus
- GI disease
- Diverticulitis
- Ulcerative colitis
- Intestinal anastomosis
- Myasthenia gravis
- Coagulopathy
- Thromboembolic disease
- Glaucoma
- Benzyl alcohol hypersensitivity

Adverse drug events:

Common: euphoria/depression, Cushing's syndrome, impaired skin healing, hypertension, GI distress, osteoporosis, skin atrophy, growth suppression, increased risk of infection

Serious: glaucoma, cataracts, hyperglycemia, adrenal insufficiency, tuberculosis reactivation

Drug interactions:

Interacting Agent	Effect	Management
Vaccines (Live)	Increased incidence of adverse effects and toxicities of vaccine Increased risk of vaccinia infection	Avoid concomitant use Use with caution in patients who have been on immunosuppressant therapy in the previous three months.
Macrolide antibiotics	Decreased metabolism of corticosteroid	Monitor toxic effects of corticosteroid
Echinacea	Decreased immunosuppression from corticosteroid	Avoid the combination if possible Monitor therapeutic efficacy of corticosteroid
Aminoglutethimide	Increased metabolism of corticosteroid	Monitor therapeutic effects of corticosteroid
Imidazole antifungals	Decreased metabolism of corticosteroid	Monitor toxic effects of corticosteroid
Acrepitant	Increased serum concentration of corticosteroid	Monitor toxic effects of corticosteroid
Barbiturates	Increased metabolism of corticosteroid	Monitor therapeutic effects of corticosteroid
Diltiazem and verapamil	Decreased metabolism of corticosteroids	Monitor toxic effects of corticosteroid
Cyclosporine	Increased serum concentration of cyclosporine Increased serum concentration of corticosteroid	Monitor toxic effects of both agents Monitor cyclosporine levels
Estrogen derivatives	Increased serum concentration of corticosteroid	Monitor toxic effects of corticosteroid
Fluconazole	Decreased metabolism of corticosteroid	Monitor toxic effects of corticosteroid

Isoniazid	Decreased serum concentration of isoniazid	Monitor therapeutic effects of isoniazid
Primidone	Increased metabolism of corticosteroid	Monitor therapeutic effects of corticosteroid
Rifamycin derivatives	Increased metabolism of corticosteroid	Monitor therapeutic effects of corticosteroid
Salicylates	Increased incidence of GI ulceration and bleeding Decreased serum concentration of salicylates	Monitor signs and symptoms of GI ulceration and bleeding Monitor therapeutic effects of salicylates Monitor toxic effects of salicylates if corticosteroid withdrawn
Vaccines (Dead)	Decreased therapeutic effect of vaccine Patient may not mount an immune response	Use caution
Progestins	Increased serum concentration of corticosteroid	No action needed

Biological Response Modifiers – Monoclonal Antibodies

Effects: Decreased frequency of allergen-induced asthma exacerbations. Reduced need for inhaled corticosteroids in maintenance treatment of asthma.

Mechanism of Action: The monoclonal antibody binds to IgE, thus interfering with mast cell binding. This prevents mast cell degranulation and release of inflammatory mediators. Cytokine release seen in the late phase of an allergic reaction is also prevented through blocking the receptors on dendritic cells, epithelial cells, eosinophils, monocytes, and platelets.

Products Available:

Generic	Trade Name	Dosage Form
Omalizumab	Xolair®	Subcutaneous injection (SC)

Special Populations:

- Pregnancy:** Risk factor category B.
- Lactation:** Unknown if excreted in human breast milk. However, IgG is excreted in breast milk, therefore it suspected that monoclonal antibodies are as well.
- Children:** No safety and efficacy data for children <12 years old.

Precautions/Contraindications:

- Hypersensitivity to hamster protein
- Hypersensitivity to the drug or its excipients
- Acute bronchospasm
- Status asthmaticus
- Corticosteroid withdrawal
- Neoplastic disease
- Populations at high risk for malignancy
- Live virus vaccines

Adverse drug effects:

Infection	Pharyngitis	Otalgia
Hematoma	Pruritis	Headache
Antibody formation	Rash	Diarrhea
Anaphylaxis	Sinusitis	Dysmenorrhea
Injection site reaction	Arthralgia	Menorrhagia
Abdominal pain	Urticaria	Nausea
Bleeding	Malignancy	Vomiting
Dizziness	Epistaxis	Fatigue
Erythema		

Omalizumab

Xolair®

Class: Biological response modifier – monoclonal antibody

Use: Treatment of asthma not adequately controlled by inhaled corticosteroids.

Dose: Initial dosing is based on weight and serum IgE levels.

MAX dose: 750 mg/4 weeks

N/A = No dose recommendations available.

		Baseline serum IgE level (IU/mL)						
		30-100	101-200	201-300	301-400	401-500	501-600	601-700
Weight (kg)	30-60	150 mg SC every 4 weeks	300 mg SC every 4 weeks	300 mg SC every 4 weeks	225 mg SC every 2 weeks	300 mg SC every 2 weeks	300 mg SC every 2 weeks	375 mg SC every 2 weeks
	61-70	150 mg SC every 4 weeks	300 mg SC every 4 weeks	225 mg SC every 2 weeks	225 mg SC every 2 weeks	300 mg SC every 2 weeks	375 mg SC every 2 weeks	N/A
	71-90	150 mg SC every 4 weeks	300 mg SC every 4 weeks	225 mg SC every 2 weeks	300 mg SC every 2 weeks	375 mg SC every 2 weeks	N/A	N/A
	91-150	300 mg SC every 4 weeks	225 mg SC every 4 weeks	300 mg SC every 2 weeks	N/A	N/A	N/A	N/A

Administration: Omalizumab is administered by subcutaneous (SC) injection only. Do not shake the reconstituted vial –swirl gently. The reconstituted solution is viscous and may take several seconds to administer. Give doses >150 mg divided at multiple injection sites.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Xolair®	Subcutaneous injection (SC)	150 mg / vial	1 vial	

Special Populations:

Pregnancy: Risk factor category B.

Lactation: Unknown if excreted in human breast milk. However, IgG is excreted in breast milk, therefore it suspected that monoclonal antibodies are as well.

Children: No safety and efficacy data for children <12 years old.

Precautions/Contraindications:

- Hypersensitivity to hamster protein
- Hypersensitivity to the drug or its excipients
- Acute bronchospasm
- Status asthmaticus
- Corticosteroid withdrawal
- Neoplastic disease
- Populations at high risk for malignancy
- Live virus vaccines

Adverse drug events:

Common: injection site reaction, headache, pain

Serious: anaphylaxis

Drug interactions:

No clinically significant interactions currently identified.

Leukotriene Receptor Antagonists

Effects: Prevention of allergen-induced bronchoconstriction.

Mechanism of Action: Antagonism of cysteinyl-leukotriene receptors, thus preventing histamine release.

Products available:

Generic name	Trade name	Dosage form
Montelukast	Singulair®	Oral tablet
Zafirlukast	Accolate®	Oral tablet

Special populations:

Hepatic impairment: Use with caution.

Elderly: Higher incidence of some side effects.

Pregnancy: Risk factor category B.

Lactation: Not recommended.

Children: Safety and efficacy data incomplete in young children.

Precautions/Contraindications:

- Status asthmaticus
- Acute bronchospasm
- Phenylketonuria
- Hepatic disease
- Corticosteroid withdrawal
- Hypersensitivity to the drug or its excipients

Adverse drug reactions:

Aggression	Hepatic failure	Dream abnormalities
Hallucinations	Churg-Strauss syndrome	Hepatitis

Montelukast

Singulair®

Class:

Leukotriene receptor antagonist

Use:

Prophylaxis and treatment of asthma and allergic rhinitis symptoms.

Dose:

Asthma or allergic rhinitis:

(Oral) 10 mg in the evening (≥15 years old)

(Oral) 4 mg in the evening (1-5 years old)

(Oral) 5 mg in the evening (6-14 years)

Administration:

Not for treatment of acute bronchospasm.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Singulair®	Oral granules	4 mg/packet	30 packets	\$102.98
	Oral tablet	10 mg	30 tablets	\$94.99
	Oral chewable tablet	4 mg	30 tablets	\$95.79
		5 mg	30 tablets	\$102.00

Special Populations:

Hepatic Impairment: Use with caution.

Pregnancy: Risk factor category B.

Lactation: Unknown if excreted in breast milk.

Children: No safety and efficacy data for children <6 months old.

Precautions/Contraindications:

- Status asthmaticus
- Acute bronchospasm
- Corticosteroid withdrawal
- Phenylketonuria
- Hypersensitivity to montelukast

Adverse drug events:

Serious: dream abnormalities, aggression, hallucinations, cholestatic hepatitis (rare), Churg-Strauss syndrome (rare)

Drug interactions:

Interacting Agent	Effect	Management
CYP2C8/9 Inducers (i.e. carbamazepine, phenytoin)	Increased metabolism of montelukast	Consider a therapeutic alternative Monitor therapeutic effects of montelukast
CYP3A4 Inducers (i.e. carbamazepine, phenytoin)	Increased metabolism of montelukast	Consider a therapeutic alternative Monitor therapeutic effects of montelukast
St. John's Wort	Increased metabolism of montelukast	Consider a therapeutic alternative Monitor therapeutic effects of montelukast
Salicylates	Increased serum concentration of montelukast	No action required

Zafirlukast

Accolate®

Class:

Leukotriene receptor antagonist

Use:

Prophylaxis and treatment of asthma.

Dose:

Asthma: (Oral) 20 mg twice daily (≥ 12 years old)

10 mg twice daily (5-11 years old)

Administration: Take without food. Give one hour before or two hours after a meal.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Accolate®	Oral tablet	10 mg	60 tablets	\$80.50
	Oral tablet	20 mg	60 tablets	\$74.99

Special Populations:

Hepatic Impairment: Dosage reduction recommended.

Elderly: Higher incidence of some side effects.

Pregnancy: Risk factor category B.

Lactation: Zafirlukast is excreted in human breast milk. Animal studies suggest that neonates and infants are more sensitive to zafirlukast. Use of zafirlukast is not recommended.

Children: No safety and efficacy data for children < 5 years old.

Precautions/Contraindications:

- Status asthmaticus
- Acute bronchospasm
- Warfarin anticoagulation therapy
- Hypersensitivity to zafirlukast
- Hypersensitivity to iodine
- Hypersensitivity to lactose
- Hypersensitivity to titanium dioxide
- Hypersensitivity to cellulose
- Cirrhosis
- Hepatitis
- Hepatic encephalopathy
- Corticosteroid withdrawal

Adverse drug events:

Serious: symptomatic hepatitis, hepatic failure, Churg-Strauss syndrome (rare)

Drug interactions:

Interacting Agent	Effect	Management
Coumarin Derivatives	Decreased metabolism of coumarin Increased serum concentration of coumarin Increased INR	Monitor INR and adjust coumarin dose accordingly
CYP 2C8/9 inhibitor (i.e. cimetidine)	Decreased metabolism of substrate Increased effect of substrate	Monitor therapeutic effects of substrate
Erythromycin	Decreased serum concentration of zafirlukast	Monitor therapeutic effects of zafirlukast
Theophylline derivatives	Increased serum concentration of zafirlukast	Monitor therapeutic effects of zafirlukast
CYP2C8/9 inducers (i.e. cimetidine, phenytoin)	Increased metabolism of zafirlukast Decreased serum concentration of zafirlukast	Choose a therapeutic alternative Monitor therapeutic effects of zafirlukast
Salicylates	Increased serum concentration of zafirlukast	No management required

Mast Cell Stabilizers

Effects:

Prevention of bronchoconstriction and inflammation.

Mechanism of Action:

Antagonize mast cell degranulation to prevent the release of histamine and other mediators of allergic reaction. Agents do not interfere with IgE. The anti-inflammatory mechanism is unknown.

Products available:

Generic name	Dosage form
Cromolyn	Metered dose inhaler (MDI) Nebulization Nasal Oral
Nedocromil	MDI Ophthalmic

Special populations:

Renal impairment: Dose reduction may be necessary.

Hepatic impairment: Dose reduction may be necessary.

Pregnancy: Risk factor category B.

Lactation: Some agents are excreted in breast milk.

Children: Safety and efficacy data incomplete in young children.

Precautions/Contraindications:

- Status asthmaticus
- Acute bronchospasm
- Cardiac disease
- Contact lenses
- Hypersensitivity to the drug or its excipients

Adverse Drug Reactions:

Bronchospasm	Headache	Nausea
Irritated/sore throat	Anaphylaxis	Vomiting
Cough	Photophobia	Ocular burning
Taste changes	Nasal irritation	Ocular stinging
Nausea	Nasal congestion	Conjunctivitis
Vomiting	Rhinitis	

Cromolyn

Crolom®
Intal®
NasalCrom®
Opticrom®

Class:

Mast cell stabilizer

Use:

Prophylaxis for asthma, exercise induced bronchospasm, and allergic disorders.

Dose:**Asthma:**

(Metered Dose Inhaler~MDI) 2 puffs 4 times daily, taper to lowest effective frequency (≥ 5 years old)

(Neb) 20 mg 4 times daily, taper to lowest effective frequency (≥2 years old)

Allergic rhinitis:

(Nasal) 1 spray into each nostril 3-4 times daily, up to 6 times/day (≥2 years old)

Administration:

Not for treatment of acute bronchospasm.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Intal®	MDI	800 mcg/actuation	8.1 g	\$65.39
			14.2 g	\$90.47
Intal®	Inhalation solution	10 mg/mL		
Cromolyn sodium	Nebulization	20 mg/2mL	60 vials	\$46.61
NasalCrom®	Nasal Spray	40 mg/mL (5.2 mg/dose)	13 mL	\$9.99
			26 mL	\$16.29
Crolom®	Ophthalmic solution	4%	10 mL	\$45.99
Opticrom®	Ophthalmic solution	4%	10 mL	\$52.99

Special Populations:

Renal Impairment: Dosage reduction recommended.

Hepatic Impairment: Dosage reduction recommended.

Pregnancy: Risk factor category B.

Lactation: Cromolyn is excreted in human breast milk.

Children: No safety and efficacy data for children < 2 years old.

Precautions/Contraindications:

- Status asthmaticus
- Hypersensitivity to cromolyn
- Coronary artery disease
- Cardiac arrhythmias
- Contact lenses
- Lactose hypersensitivity

Adverse drug events:

Common: throat irritation, cough, bad taste

Serious: bronchospasm, anaphylaxis

Drug interactions:

No clinically significant interactions currently identified.

Nedocromil

Tilade®
Alocril®

Class:

Mast cell stabilizer

Use:

Maintenance therapy for asthma (mild to moderate). Ophthalmic solution used to treat pruritus due to allergic conjunctivitis.

Dose:**Asthma:**

(Metered Dose Inhaler~MDI) 2 puffs 4 times per day (≥6 years old)

Allergic conjunctivitis:

(Ophth) 1-2 drops in each eye twice daily (≥3 years old)

Administration:

Not for treatment of acute bronchospasm.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Tilade®	MDI	1.75 mg/ actuation	16.2 g	\$71.62
Alocril®	Ophthalmic solution	2%	5 mL	\$72.01

Special Populations:

Pregnancy: Risk factor category B.

Lactation: Unknown if nedocromil is excreted in human breast milk.

Precautions/Contraindications:

- Status asthmaticus
- Acute bronchospasm
- Hypersensitivity
- Contact lenses

Adverse drug events:

Common: dizziness, headache, photophobia, conjunctivitis, nasal congestion, bad taste, sore throat, nausea, ocular stinging, cough, vomiting, ocular burning, rhinitis

Drug interactions:

No clinically significant interactions currently identified.

Methylxanthine Derivatives

Effects: Bronchodilation independent of mechanism of bronchoconstriction. Secondary effects include increased strength of diaphragm, decreased fatigue, CNS stimulation, improved response to hypoxemia, decreased lower esophageal sphincter tone, increased gastric acid secretion, and a short-term diuretic effect.

Mechanism of Action: The inhibition of phosphodiesterase stops the breakdown of 3',5'-cAMP at high doses. Proposed mechanisms of action include prostaglandin antagonism, stimulation of endogenous catecholamines, inhibition of calcium influx into smooth muscle (preventing muscle contraction), antagonism of adenosine receptors, and inhibition of release of mediators from leukocytes and mast cells.

Products available:

Generic name	Trade name	Dosage form
Theophylline	Elixophyllin	Oral elixir
	Quibron -T	Tablet
	Quibron-T/SR	ER-tablet
	Theo-24	ER-capsule
	Theochron	ER-tablet
	Theolair	Oral solution Tablet
	Theophylline CR	12-hour capsule
	T-Phyl	ER-tablet
	Uniphyl	24-hour tablet

Aminophylline	Various generics	Intravenous injection Oral solution Oral tablet
	Truphylline	Suppository
Caffeine Citrate	Cafcit	Oral solution Intravenous injection
Dyphylline	Dilor	Oral tablet
	Dilor-400	Oral tablet
	Lufyllin	Oral tablet
Oxtriphylline	Choledyl SA	Extended release oral tablet

Special Populations:**Renal Impairment:** Dose reduction may be necessary.**Hepatic Impairment:** Dose reduction may be necessary**Elderly:** Dose reduction recommended.**Pregnancy:** Insufficient evidence to recommend use during pregnancy.**Lactation:** Theophylline is excreted in human breast milk.**Children:** Dose reduction recommended in neonates, especially if premature, or with kidney or liver impairment.**Precautions/Contraindications:**

- Cardiac disease
- Coronary artery disease
- Cor pulmonale
- Cardiac arrhythmias
- Congestive heart failure
- Myocardial infarction
- Regular ethanol consumption
- Tobacco smoking
- Passive smoke exposure
- Gastritis
- Peptic ulcer disease
- Gastroesophageal reflux disease
- Hiatal hernia
- Seizure disorder
- Hypersensitivity to theophylline
- Cholestasis
- Hypothyroidism
- Acute pulmonary edema

- Sepsis with multiple organ failure
- Shock
- Hyperthyroidism
- Cystic fibrosis
- Acidemia
- Viral pulmonary infection
- Prolonged fever
- Influenza vaccine
- Respiratory tract infection
- Severe hypoxemia
- Urinary retention
- Benign prostatic hypertrophy
- Hypersensitivity to corn

Adverse Drug Reactions:

Seizures
Permanent neurologic deficits
CNS stimulation
Restlessness
Irritability
Insomnia
Headache

Tachycardia
Arrhythmias
Tachypnea
Nausea
Vomiting
Anorexia

Diarrhea
Death
Hyperglycemia
Diuresis (tolerance develops quickly)
Urinary retention
Hypokalemia

Theophylline

Quibron-T
Quibron-T/SR
Theo-24
Theolair
T-Phyl
Theochron
TheophyllineER
Uniphyl
Elixophyllin

Class:

Methylxanthine derivative

Use:

Treatment of asthma, bronchitis, and COPD symptoms of reversible airway obstruction

Dose:**Asthma or COPD:**

(Oral, IR) Loading dose: 5 mg anhydrous theophylline/IBW, then
300 mg/day divided every 6-8 hours x 3 days, then
400 mg/day divided every 6-8 hours x 3 days, then
600 mg/day divided every 6-8 hours

(Oral) ER-12 hr) 300 mg/day divided every 12 hours x 3 days, then
400 mg/day divided every 12 hours x 3 days, then
600 mg/day divided every 12 hours

(Oral, ER-24 hr) 300-400 mg once daily x 3 days, then
400-600 mg once daily x 3 days, then titrate according to blood level

(IV) Loading dose: 5 mg/kg over 20-30 minutes, then
0.4 mg/kg/hr continuous infusion

Asthma (children < 45 kg):

MAX daily dose: (full term, 26-52 weeks old)
 $\{[0.2 \times (\text{age in weeks}) + 5] \times \text{body weight in kg}\} / \text{day}$ divided every 6 hours
MAX daily dose: (full term, 6-26 weeks old)
 $\{[0.2 \times (\text{age in weeks}) + 5] \times \text{body weight in kg}\} / \text{day}$ divided every 8 hours
MAX daily dose: (premature, >24 days old)
1.5 mg/kg every 12 hours
MAX daily dose: (premature, <24 days old)
1 mg/kg every 12 hours

(Oral, ER-12 hr) 6-12 mg/kg every 12 hours, (MAX 300 mg/d) x 3 days, then
8 mg/kg every 12 hours, (MAX 400 mg/d) x 3 days, then
10 mg/kg every 12 hours, (MAX 600 mg/d)

(Oral, ER-24 hr) 12-24 mg/kg once daily, (MAX 300 mg/d) x 3 days, then
16 mg/kg once daily, (MAX 400 mg/d) x 3 days, then
20 mg/kg once daily, (MAX 600 mg/d)

(IV) Loading dose: 5 mg/kg, then
0.7 mg/kg/hr, (9-16 years old), or
0.8 mg/kg/hr, (1-9 years old), or
[0.008 x (age in weeks) + 0.021] mg/kg/hr, (full term, ≤1 year old)

Administration:

(Oral): Take long acting preparations with a full glass of water, do not chew or crush dosage form. Extended release capsules may be opened and sprinkled on soft food. Scored tablets can be cut in half. Absorption of some dosage forms may be altered by food. Take with water one hour before or two hours after meals.

How supplied:

Product	Dosage form	Dose	Package size	Pricing as of 09/16/05 (www.drugstore.com)
Theophylline CR	12-hour capsule	100 mg	60 tablets	\$8.99
			60 tablets	\$9.99
		125 mg	60 tablets	\$16.99
		200 mg	60 tablets	\$15.99
			60 tablets	\$18.99
		300 mg	60 tablets	\$17.99
			60 tablets	\$10.99
		450 mg	60 tablets	\$24.99

Uniphyl	24-hour tablet	400 mg	60 tablets	\$63.79
		600 mg	60 tablets	\$91.99
Elixophyllin	Oral elixir	80 mg/15mL	480 mL	\$96.40
Quibron-T	Tablet	300 mg	60 tablets	\$35.99
Quibron-T/SR	ER-tablet	300 mg		
T-Phyl	ER-tablet	200 mg		
Theo-24	ER-capsule	100 mg	60 capsules	\$26.56
		200 mg	60 capsules	\$38.84
		300 mg	60 capsules	\$45.99
		400 mg	60 capsules	\$63.39
Theochron	ER-tablet	100 mg		
		200 mg	60 tablets	\$23.06
		300 mg		
Theolair	Oral solution	80 mg/15mL		
	Tablet	125 mg	60 tablets	\$31.99
		250 mg	60 tablets	\$48.99

Special Populations:

Elderly: Dose reduction recommended.

Pregnancy: Risk factor category C.

Lactation: Theophylline is excreted in human breast milk.

Children: Dose reduction recommended in neonates, especially if premature, or with kidney or liver impairment.

Precautions/Contraindications:

- Cardiac disease
- Coronary artery disease
- Cor pulmonale
- Cardiac arrhythmias
- Congestive heart failure
- Myocardial infarction
- Regular ethanol consumption
- Tobacco smoking
- Passive smoke exposure
- Gastritis
- Peptic ulcer disease
- Gastroesophageal reflux disease
- Hiatal hernia
- Seizure disorder
- Hypersensitivity to theophylline
- Cholestasis
- Hypothyroidism
- Acute pulmonary edema
- Sepsis with multiple organ failure
- Shock
- Hyperthyroidism
- Cystic fibrosis
- Acidemia
- Viral pulmonary infection
- Prolonged fever
- Influenza vaccine
- Respiratory tract infection
- Severe hypoxemia
- Urinary retention
- Benign prostatic hypertrophy
- Hypersensitivity to corn

Adverse drug events:

Common: tachycardia, restlessness, insomnia, headache, tremor, nausea, vomiting

Serious: convulsions, ventricular arrhythmias, severe vomiting, bradycardia

Drug interactions:

Agents that increase the risk of theophylline toxicity:

Activated charcoal	Ephedrine	Oral contraceptives
Acyclovir	Famotidine	Propafenone
Allopurinol	Fluvoxamine	Quinolones
Amiodarone	Food	Ranitidine
Beta agonists	Influenza vaccine	Tacrine
Beta blockers, nonselective	Interferon	Terbinafine
Caffeine	Iodine 131 (hypothyroidism)	Tetracyclines
Carbamazepine	Isoniazid	Thiabendazole
Cimetidine	Loop diuretics	Thyroid (hypothyroidism)
Corticosteroids	Macrolides	Ticlopidine
Diltiazem	Mexiletine	Verapamil
Disulfiram	Nifedipine	Zafirlukast
	Omeprazole	

Agents that may reduce the therapeutic efficacy of theophylline:

Aminoglutethimide	Ketoconazole	St. John's Wort
Barbiturates	Carbamazepine	Thioamines (hyperthyroidism)
Felodipine	Lansoprazole	Food
Hydantoins	Rifamycins	Isoniazid
Beta agonists	Sulfinpyrazone	Loop diuretics
Beta blockers, nonselective		

Other interacting agents (effects):

Adenosine (effects antagonized)
Benzodiazepines (sedative effect antagonized)
Halothane (arrhythmias)
Hydantoins (decreased effect)
Ketamine (seizures)
Beta blockers, nonselective (decreased effects of both agents)
Lithium (decreased serum concentration)
Carbamazepine (decreased serum concentration)
Non-depolarizing muscle relaxants (reversal of relaxation)
Corticosteroids (increased prednisone activity)
Tacrolimus (increased serum creatinine, increased serum tacrolimus concentrations)
Macrolides (decreased serum concentration of erythromycin)
Zafirlukast (serum concentration decreased)
Food

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